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246. THE FLORA OF THE SHIOTSUBO FORMATION OF THE AIZU LIGNITE-FIELD, HUKUSHIMA PREF., JAPAN*

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福島県会津亜炭田塩坪層の植物群：会津亜炭田の含植物化石層（塩坪層，藤峠層及び和泉層）のうち最下位の塩坪層の植物化石を取扱つた。本層は海成層で耶摩動物群を含み上部中新世と考へられている。植物化石は本層最上部の葉状凝灰岩に含まれている。種類は僅か14でこのうち新種は3，溫冷型を示し本州北部及び北海道南部森林の組成に近く又仙台附近の根の白石植物群に似ている。上部中新世に対比する。

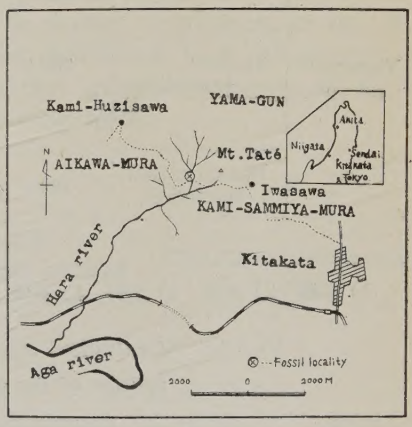
藤岡一男・鈴木敬治

Recent field study of the junior author of the Aizu lignite-field, Hukushima prefecture has resulted in the discovery of three plant-bearing formations, namely the Shiotsubo formation of the Yamasato group, the Huzitoge formation and the Izumi formation of the Yamato group. It is the purpose of this brief note to record a small flora from the Shiotsubo formation among these three.

The geologic succession of the Neogene Tertiary deposits of the Aizu lignite-field were clarified by the junior author in 1951, taking the central part of the western border of the Aizu basin as the type locality, as shown in Table 1.

The collection was made by the junior author at an exposure of the upper course of the Hara river, a tributary of the Aga river, about 4 km northwest of Kitakata city, Aizu basin, Hukushima prefecture. As shown in Fig. 1, the locality of fossil plants is situated on the route side from Iwasawa of Kamisammiya-mura to Kamihuzisawa of Aikawa-mura in Yama-gun.

Text-fig. 1-Map showing the locality of the Shiotsubo flora.



Fossil leaves here described were discovered from the uppermost laminated tuff of the Shiotsubo formation which is considered to be of marine deposits in origin. As its stratigraphic position is shown in Text-fig. 2, the leaf-bearing laminated tuff is underlain by the coarse-grained sands, which contains abundant

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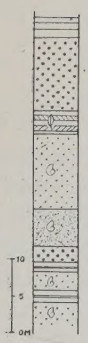
Table 1. Stratigraphic succession of the Neogene Tertiary rocks in the Aizu lignite-field, Hukushima pref., in ascending order.

Formations		Thickness (m)	Lithic characters	Fossils
Granodiorite				
Yamasato[1] group	Kagata[2] formation	60–90	Basal conglomeratic sandstone, liparite flow, fine-grained sandstone, and alternation of green tuff and sandstone.	Marine molluscs
	Oginc[3] formation	150–200	Green tuff, tuffaceous sandstone and green sandstone, interbedded with plagio-liparite flow.	Marine molluscs
	Urushikubo[4] formation	80–100	Alternation of sandstone and mudstone, and mudstone.	Marine molluscs and foraminifers
	Shiotsubo[5] formation	100–180	Alternation of conglomerate, sandstone and mudstone.	Marine molluscs (Yama fauna) and plants(**Shiotsubo**) **flora**)
Yamato[6] group	Huzitoge[7] formation	150–180	Alternation of conglomerate, sandstone, mud stone and tuff, with many lignite seams; cross bedded.	Plants (**Huzitoge flora**)
	Izumi[8] formation	200±	Alternation of conglomerate, sandstone, mudstone and tuff, with lignite seams; cross bedded.	Plants (**Izumi flora**)
	Nanaorizaka[9] formation	100±	Conglomerate and tuff.	
River terrace deposit				

1) 山郷 2) 利田 3) 萩野 4) 漆窪 5) 塩坪 6) 山都 7) 藤峠 8) 和泉 9) 七折坂

Text-fig. 2 Generalized columnar section showing the stratigraphic position of the plant-bearing laminated tuff.



Huzitoge formation	Coarse-grained sands	
Shiotsubo formation	Laminated tuff	The Shiotsubo flora
	Medium-grained sandstone	The Yama fauna (*Yoldia johanni, Pecten kimurai, Cardium iwashiroense, Serripes yokoyamai, Lucinoma acutilineata, Thyasira nipponica, Mya urushikuboana*, etc.)
	Tuffaceous massive sandstone. Alternation of conglomerate, sandstone and mudstone	

marine molluscs of the Yama fauna (OTUKA, 1942) and has been believed by Japanese palaeontologists to be of the Upper Miocene. The leaf-bearing laminated tuff is about 3 m thick and consists of fine alternation of tuff, tuffaceous sandstone-mudstone. Plant impressions are crowded and well-preserved, but the rock is so weak that the specimens were mostly broken into fragmental pieces.

The authors discriminated the following only 14 plants in the Shiotsubo flora. Most of them are specifically undefined as the materials are incomplete to decide their accurate specific names.

Plants of the Shiotsubo flora

Family Salicaceae
- *Populus aizuana*, sp. nov.
- *P. Sambonsgii*, sp. nov.
- Cfr. *Salix Lackschewitziana* TAEPER
- Cfr. *S. jessoensis* SEEMEN

Family Betulaceae
- Cfr. *Alnus japonica* SIEB. et ZUCC.
- *A. tinctoria* SARGENT
- Cfr. *Betula Ermanni* CHAMISSO
- *Carpinus erosa* BLUME

Family Fagaceae
- Cfr. *Fagus crenata* BLUME

Family Ulmaceae
- *Zelkowa Ungeri* (ETT.) KOVATS

Family Papillionaceae
- *Wistaria floribunda* A.P. DE CANDOLLE

Family Aceraceae
- *Acer debilum*, sp. nov.
- *A.* sp.

Family Tiliaceae
- *Tilia* sp.

The Shiotsubo flora contains 14 species, representing 9 genera of 7 families, and is characterised by the dominance of Salicaceae and Betulaceae. It is interesting that none of coniferous trees such as *Metasequoia* and *Glyptostrobus* which are so common in the Tertiary floras of Japan were not found. All of the Shiotsubo plants hitherto known are considered to be deciduous broad-leaved trees, shrubs and vein.

The modern equivalents of the Shiotsubo plants and their geographic distribution may be enumerated as the following table:

Shiotsubo species	Modern equivalents in Japan	Geographic distribution in Japan
Populus aizuana, sp. nov.		
P. Sambonsgii, sp. nov.		
Cfr. *Salix jessoensis*	*S. jessoensis* SEEM.	H Nh
Cfr. *S. Lackschewitziana*	*S. Lakschewitziana* TAEPER	H Nh
Cfr. *Alnus japonica*	*A. japonica* S. et Z. var. *arguta* CALL.	H Nh
A. tinctoria	*A. tinctoria* SARGENT var. *obtusiloba* CALL	H Nh Ch Sh S K
Cfr. *Betula Ermanni*	*B. Ermanni* CHAM.	H Nh Ch Sh S K
Carpinus erosa	*C. erosa* BLUME	H Nh Ch Sh S
Cfr. *Fagus crenata*	*F. crenata* BLUME	H Nh Ch Sh S K
Zelkowa Ungeri	*Z. serrata* MAKINO	Nh Ch Sh S K
Wistaria floribunda	*W. floribunda* A. P. DE CANDOLLE	Nh Ch Sh S K
Acer debilum, sp. nov.	*A. ornatum* CARR.	H Nh Ch Sh S K

A. sp.	*A. aizuense* NAKAI	H Nh Ch Sh S K
Tilia sp.	*T. japonica* SIMK.	H Nh Ch Sh S K

H (Hokkaido), Nh (Northern Honsyu), Ch (Central Honsyu),
Sh (Southern Honsyu), S (Shikoku), K (Kyusyu)

Excluding two species which equivalents are found in North America, all others are now living in Japan, particularly in its northern parts. It is presumable that the Shiotsubo flora may be correlatable in the floral association most closely to the modern forests of Northern Honsyu and Southern Hokkaido. The climatic condition under which the Shiotsubo flora grew is considered to be a little colder than the Aizu basin at present.

As the Shiotsubo flora comprising only 14 spceies it is difficult to determine its geological age on the base of the flora only. However, as far as we know, the Nenoshiroishi flora near Sendai seems to be most comparable with our flora. According to OKUTSU (1940), 84 species of the Nenoshiroishi flora are distributed in 46 genera and 29 families, besides 5 undeterminable plants, and the dominant families of the flora are Betulaceae, Fagaceae and Aceraceae. He concluded that the Nenoshiroishi flora grew under somewhat colder condition in the Upper Miocene age than at present. Comparing our 14 species with the Nenoshiroishi species, as shown in the following table, the floral affinity between the two is clearly great at least in the ecological condition.

Comparison of the Shiotsubo species with the Nenoshiroishi species

Shiotsubo species	Related species in the Nenoshiroishi flora (OKUTSU, 1940)
Populus Sambonsgii, sp. nov.	*P. balsamoides* GÖPPERT
Alnus tinctoria SARGENT	*A. hirsuta* TURZ.*
Cfr. *Betula Ermanni* CHAM.	*B. Ermanni* CHAM.*
Carpinus erosa BLUME	*C. cordata* BLUME*
Cfr. *Fagus crenata* BLUME	*F. crenata* BLUME*
Zelkowa Ungeri (ETT.) KOVATS	*Z. serrata* MAKINO*
Acer debilum, sp. nov.	*A. eupalmatum* KOIDZ.
Tilia sp.	*T. distans* NATHORST

* Marked species are numerous common elements in the Nenoshiroishi flora.

It would be almost safe that the Shiotsubo flora is nearly contemporaneous with the Nenoshiroishi flora in geological age, and the Shiotsubo formation as a whole is of the Upper Miocene. This correlation has been supported by the faunal evidences of the Yama fauna in the Shiotsubo formation.

Description of Species

Genus *Populus* L.

Populus aizuana, sp. nov.

Plate 16, Figures 1-4

Description:—Leaf deltoid or broadly diamond, 5–8 cm long and 6–8 cm wide, a little wider than the length, abruptly acute to acuminate at the apex, cuneate to truncate at the base. Margin wavy crenato-dentate. Midvein stout, tapered, slightly undulate at the course to the apex; lateral veins rather irregularly alternate or subopposite, 5–7 pairs in number, leaving the midvein at angles of 40–60°, gently curved apically, undulating slightly at the way to the marginal border, diverged some branches near the margin to form loops with the neighbourings and to be camptodromous; interstitial veins and cross veins strong, rather irregular; finer veins formed reticular or polygonal meshes. Petiole stout, longer than 2 cm, flattened near point of attachment to leaf. Texture thin.

Comparison and remarks:—This species are represented by leaves which are considerably variable either in size or shape. Small leaves show the ovate outline with acutely crenate margin, while the larger leaves, as shown in figures, are deltoid or broadly diamond bearing crenato-dentate margin.

Of the living species, our specimens are somewhat related to *Populus Sieboldi* Miq. of Japan and *P. ezoensis* Nakai of Korea and Hokkaido, but more closely similar to North American *Populus*, such as *P. grandidentata* Michx., *P. tremuloides* Michx. and *P. Fremonti* S. Wats.

Our specimens are referable to none of the Japanese fossil species hitherto reported, but are more or less comparable with some foreign species; they are *P. latior* Al. Braun (1845, p. 167) which is extensive in the Miocene floras of Eurasia and occurs also from the Japanese Miocene, *P. prefremonti* Dorf (1930, p. 77, Pl. 7, Fig. 4) which is common in the Neogene floras of Western United States, and *P. pliotremuloides* Axelrod (1938, p. 169, Pl. 4, Figs. 1–3) of the Pliocene Mount Eden flora of California.

Occurrence: Abundant

Populus Sambonsgii, sp, nov.

Plate 16, Figures 5–7

Description:—Leaf reniform or broadly deltoid, 5–6 cm long, 4.5–5.0 cm wide, a little longer than the breadth, rather abruptly acuminate at the apex, slightly cordate or broadly truncate at the base. Margin shallowly serrate, marginal teeth curving up-inwards. Nerves subtriveined: Midvein thick, tapered to the apex, almost straight or slightly curving; a pair of basal secondaries diverged at an angles about 45° from the midvein at the blade base, more or less curving upwardly; abaxial secondaries 5–6 in number, diverged from the basal secondaries; remaining secondaries 5–7 pairs, alternate to subopposite, diverging from the midvein at 45° angles approximately, curving apically, forming marginal loops with the adjacents to be camptodromous, as well as in the abaxial secondaries; finer veins in caliber formed large to small, well-defined irregular polygonal meshes. Petiole thick, about 3.5 cm long. Texture seems to be rather thin.

Comparison and remarks:—The present leaf bears a definite resemblance

to the American living species, such as *Populus tacamahaca* MILL. and *P. trichocarpa* HOOK, rather than to the Japanese livings. *P. tacamahaca*, which is one of the sub-Arctic American trees, is much longer being ovato-lanceolate in outline. *P. trichocarpa*, which now grows in the Pacific region from California to southern Alaska, is much larger than ours and rounded or abruptly cuneate at the base. Among the living *Populus* of Japan *P. Sieboldi* MIQ. more or less resembles ours. Of the Chinese species, *P. yunnanensis* DODE somewhat related to ours.

P. Sambonsgii, sp. nov. is easily distinguished from *P. aizuana* by the basal characters and the marginal serration. There are no referable fossil *Populus* in the Japanese Tertiary floras. This species somewhat resembles *P. Alexanderi* DORF (1930, p. 75, Pl. 6, Figs. 9-11; Pl. 7, Figs. 1-3) of the Neogene floras of Western United States, but its lateral veins are more densely arranged than in ours.

This new species is named in honor of Prof. M. SAMBONSGI of the Department of Arts and Sciences, Hukushima University.

Occurrence: Common

Genus *Salix* L.

Cfr. *Salix jessoensis* SEEMEN

Plate 16, Figure 9

Description:—Leaf lanceolate, 8 cm long and 1.5 cm broad, long acuminate at the apex, acute at the base. Margin finely serrate. Midvein thick and straight to the apex. Lateral veins numerous, rather irregularly and densely arranged, leaving the midvein at angles of 40–50°, slightly curved apically and ascend along the margin to connect with the upper adjacent to be camptodromous. Finer veins networked. Petiole thick and short. Texture rather thin.

Comparison and remarks:—Only one specimen, which is almost complete, was obtained. Comparable living species of *Salix* with the present leaf are rather common. Among them, our leaf is most closely referable to *S. jessoensis* SEEMEN, which now grows commonly at riversides of Hokkaido and northern Honsyu in Japan.

Four species of *Salix* have been recorded from the Japanese Neogene Tertiary; they are *S. varians* GÖPPERT, *S. Lavateri* HEER, *S. gracilistyla* MIQ. and *S. triandra* L. var. *nipponica* SEEMEN.

Occurrence: Rare

Cfr. *Salix Lackschewitzina* TAEPER

Plate 16, Figure 8

A single incomplete specimen was determined. It is almost unseparable from *Salix Lackschewitziana* TAEPER as far as its observable characters of leaf are concerned. *S. Lackschewitziana* is living at riversides of Hokkaido and northern Honsyu in Japan, and more widely extending to Sachalien, Korea, Amur and Ussuri.

Occurrence: Rare

Genus *Alnus* GAERTN.

Cfr. *Alnus japonica* SIEB. et ZUCC.

General character of leaf is, though it is made up from fragmental specimens, strongly akin to the modern *Alnus japonica* SIEB. et ZUCC., particularly to its var. *arguta* CALL. *A. japonica* is commonly distributing at borders of swamps and streams in almost whole Japan, and extending westwards to

Korea and Manchuria; var. *arguta* is also common at swamps of Hokkaido and northern Honsyu of Japan.

A. japonica and its allied forms are not rare in the Neogene and Pleistocene floras of Japan (MIKI, 1938, 1941, 1948).

Occurrence: Common

Alnus tinctoria SARGENT

1938. *Alnus tinctoria*, MIKI: p. 229, Pl. 5, Fig. R.
1940. *Alnus hirsuta* TURZ. var. *sibirica*, ENDO: p. 50, Pl. 10, Figs. 5, 22.
1940. *Alnus hirsuta*, OKUTSU: p. 157, Pl. 10, Figs. 3, 4.
1948. *Alnus tinctoria*, MIKI: p. 112.

Some fragmental leaves were determined. They are quite identical with the existing *Alnus tinctoria* SARGENT and are undistinguishable from its var. *obtusiloba* CALL. which is common in the temperate forests of Japan.

A. tinctoria has been known since the Upper Miocene in Japan. In 1888, NATHORST figured *A.* sp. (cfr. *A. incana* WILLD) (p. 30, Pl. 7, Fig. 9) from Seki of Sado Is., Niigata pref. is surely related to *A. tinctoria*, but distinctly differs from the modern species. *A. incana* recorded by SCHMALHAUSEN (1887, p. 202, Pl. 19, Fig. 14; p. 203, Pl. 20, Figs. 3–9 from the Altai Mountains Miocene deposits is also similar to *A. tinctoria*.

Occurrence: Common

Genus *Carpinus* L.

Carpinus erosa BLUME

1931. *Carpinus cordata*, KON'NO: Pl. 1, Fig. 7; Pl. 2, Fig. 4; Pl. 8, Figs. 9, 10,
1933. *Carpinus cordata*, ENDO: p. 40, 3 in Text-fig. 9.
1938. *Carpinus erosa*, MIKI: p. 229, Pl. 4, Fig. K; Pl. 10 G.
1940. *Carpinus cordata*, ENDO: p. 54, Pl. 7, Figs. 5, 9, 10, 13, 19.
1948. *Carpinus erosa*, MIKI: p. 112.

Carpinus erosa BLUME now distributes in Hokkaido, Honsyu and Shikoku in Japan, and extends more westwards to Korea, China, Manchuria and Ussuri. It is one of the representative trees of Northeastern Asiatic temperate forests. Fossils of *C. erosa* and its similar species have been recorded from several localities of Japan since the Miocene.

Occurrence: Rare

Genus *Betula* L.

Cfr. *Betula Ermanni* CHAMISSO

Though our specimens are incomplete, the leaf character strongly resembles the living *Betula Ermanni* CHAM. *B. Ermanni* and its varieties are the representative sub-Arctic trees of Northeastern Asia, distributing widely in Kamtchatka, Aleutian Islands, Kulile Islands, Sachalien, Japanese Islands, Korea, Eastern Siberia and Unalaska. In the central part of Japan they grow on mountains higher than 1300 m in elevation.

Fossils of *B. Ermanni* were reported from the Upper Miocene Nenoshiroishi plant beds (OKUTSU, 1940, p. 158, Pl, 10, Figs. 1–2) and the Pleistocene Shiobara bed (ENDO, 1940, p. 51, Pl. 8, Figs. 4, 24).

Occurrence: Rare

Genus *Fagus* L.

Cfr. *Fagus crenata* BLUME

Plate 16, Figure 10

Some leaves of *Fagus*, which are closely comparable with the living *Fagus crenata* BLUME, were obtained. As

shown in Fig. 10, our leaves are characterised by the presence of distinct marginal teeth, which are occasionally seen in the living leaves of *F. crenata*. Neogene *Fagus* of Japan, which bears serrate margin such as our present leaves, has been treated under the name of *F. ferruginea* AIT. (NATHORST, 1883, p. 43, Pl. 4, Figs. 11–24; Pl. 5, Figs. 1–11; Pl. 6, Fig. 1). Comparing our specimens with the related species of modern *Fagus*, they seem to be more closely similar to *F. crenata* than to *F. grandifolia* and other species. In the present disposal, it is considered inadvisable to apply the name *F. ferruginea* to our specimens until more definitive materials are available, therefore, the authors wish to treat them as cited above.

F. grandifolia EHRH. (=*F. americana* SWEET and *F. ferruginea* AIT.) is now existing in North America. *F. crenata* is common in the temperate forests of Japan and grows in forests higher than 300 m in elevation at the Aizu basin.

Occurrence: Common

Genus *Zelkowa* SPACH

Zelkowa Ungeri (ETTINGSHAUSEN) KOVATS

1951. *Zelkowa Ungeri*, HUZIOKA: p. 71, Pl. 5, Fig. 9.

Some detached leaves identified to *Zelkowa Ungeri* are closely related to *Z. serrata* MAKINO which is living in Japan and Korea.

Z. Uugeri has been widely known from the Tertiary floras of Eurasia and is one of the most common species even in the Neogene floras of the Far East.

Occurrence: Rather rare

Genus *Wistaria* NUTT

Wistaria floribunda A.P. DE CANDOLLE

1937. *Wistaria floribunda*, MIKI: p. 318, Figs. 6F–H.
1938. *Kraunhia floribunda*, HUZIOKA: p. 148.
1938. *Wistaria floribunda*, MIKI: p. 220, Fig. 5G; p. 223; p. 224, Fig. 6J; p. 237, Fig. 14K.

Material is a detached leaflet, but it is so well-preserved that is quite identical with the living *Wistaria floribunda* A.P. de CANDOLLE. This species in common in Honsyu and Kyusyu of Japan, and fossils of leaflets, pods, spines and shoots have been recorded from the Japanese Pliocene and Pleistocene floras.

Occurrence: Rare

Genus *Acer* L.

Acer debilum, sp. nov.

Plate 16, Figures 11–12.

Description:—Leaf small, palmately 5–7 lobed, very deeply dissected. Lobe linear lanceolate, broadest at a little below the middle part, thence gradually tapering bothwards, long acuminate at the apex, connected with the neighbouring lobes near the basal part; the median lobe is largest, of the specimen shown in Fig. 11 measuring 4 cm in length and 0.8 cm in breadth. Primary veins 5–7 in number, palmately disposed from the base of lamina corresponding to each lobe, straight to the tip of lobe, diverging some lateral veins at an acute angles toward the margin to be camptodromous. Margin roughly serrate, the teeth being large and sharply pointed. Base of leaf slightly cordate. Petiole unknown. Texture thin.

Comparison and *remarks*:—*A. debilum*, sp. nov. is named on somewhat incomplete specimens which are lacking their petioles, but is distinct from the known species in the deeply dissected narrow lobes. This species is essentially related to *Acer ornatum* CARR. which distributes widely in Northeastern Asia containing many varieties and formas. *A. formosum* CARR., which is common in Japan, is also somewhat akin to this fossil.

A. debilum is quite similar to *A. eupalmatum* KOIDZ. figured by ENDO (1934, p. 240, Pl. 29, Fig. 5; Pl. 34, Fig. 4; Pl. 35, Figs. 6–8, 19) from the Pleistocene Shiobara plants bed, but the lobes are more narrowly lanceolate than those of the Shiobara leaves. *A. ornatum* reported by TANAI (1952, p. 234, Pl. 22, Fig. 10) from the Enniti series of Korea is also similar to our *A. debilum*, but his lobe is more shallowly dissected than in our species. There are no comparable species with *A. debilum* among the foreign *Acer*s in both of the fossil and the living.

Occurrence: Rather rare

Acer sp.

Plate 16, Figure 13.

Description:—Samara small, splitting angle with a pair shows 20°. Seed ellipsoid, about 8 mm long and 4 mm wide, with some longitudinal grooves on the surface. Wing incomplete, longer than 1 cm and at least 7 mm wide, constricted at the base, straight at the outer margin.

Comparison and remarks:—Only one incomplete samara was obtained from the same locality with *A. debilum*. This samara, however, seems to be similar to *A. aizuense* NAKAI, which now grows in forests of moist soil in Hokkaido, Honsyu, Shikoku and northern Kyusyu.

Occurrence: Rare

Genus Tilia L.

Tilia sp. indet.

Some fragmental leaves which are referable to the genus *Tilia* were determined. They may be akin to *T. japonica* SIMONKAI which is existing in Hokkaido, Honsyu and Kyusyu.

Occurrence: Rather rare

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Explanation of Plate 16

(The figures are all natural size unless otherwise stated)

The specimens are stored in the Institute of Earth Science, Department of Arts and Sciences, Hukushima University.

Locality: About 1 km west of Mt. Taté, upper course of the Hara river, a tributary of the Aga river, route-side between Iwasawa of Kamisammiya-mura and Kamihuzisawa of Aikawa-mura, Yama-gun, Hukushima Prefecture. (see, Fig. 1); Shiotsubo formation of Yamasato group (Upper Miocene); Coll. K. SUZUKI.

福島県耶摩郡相川村上藤沢・上三宮村岩沢間の路傍, 阿賀川支流原川上流館山西方1粁; 山郷層群塩坪層 (上部中新世); 鈴木敬治採集

Takayasu, Photo.

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 14, pp. 143-148, Pls. 17-18, Aug. 15, 1954

247. ELECTRON-MICROSCOPIC FINE STRUCTURE OF FOSSIL DIATOMS, II*

HARUO OKUNO

Kyoto University of Textile Fibers

化石珪藻の電子顕微鏡的微細構造. II: *Melosira granulata* (大分県山移村産) 及び f. *curvata* (韓国甘浦産), *Achnanthes lanceolata* f. *ventricosa* (北海道真狩別村産), *Actinella brasiliensis* (三重県有井村産), *Actinocyclus ellipticus* (佐渡ヶ島沢根町産), *Auliscus pruinosus* (大阪府寝屋川市産), *Campylodiscus Daemelianus* (大阪府茨木市産), *Camp. echeneis* (大阪府茨木市産), *Cymbella Ehrenbergii* (長野県鯛津村産), *Opephora Martyi* (北海道喜茂別村産), *Didymosphenia geminata* var. *curvata* (佐賀県嬉野町産), *Navicula americana* (熊本県西瀬村産) などの微細構造について記した。 奥 野 春 雄

Melosira granulata (EHRENBERG) RALFS

Pl. 17, Figs. 1a, b.

Melosira granulata (EHRENBERG) RALFS, HANNA and GRANT, 1929, *Journ. Paleont. vol. 3*, p. 95, pl. 12, figs. 8. 9.-HUSTEDT, 1930, Kieselalg., Teil. 1, p. 248, fig. 104.-MILLS, 1934, Index, p. 929.-OKUNO, 1944, *Kagaku* (*Science*), *Tokyo, vol. 14*, p. 307, fig. 1-f, h, fig. 4.-CLEVE-EULER, 1951, Diat. Schweden u. Finnland, p. 24.

Mel. granulata f. *reticulata* O. MULLER, CLEVE-EULER, 1951, l. c., p. 25.

Frustules cylindric. Diameter about 12–35 (5–35) μ. Frustule pores, locular, regular or scalene quadrilateral, sometimes scalene polygonal, 6–7 (6–12) in 10 μ, arranged in straight or slightly curved longitudinal rows. Sieve membranes of the lôculi scattered with sieve pores of various shapes and sizes. Sieve pores roundish (about 50-100 mμ in diameter) and larger in the centre of the sieve membrane, roundish-polygonal, and smaller at the margin. Sieve pores often divided into several micropores. In many frustules, the sieve membranes are lost. The fine structure of the sieve membrane of the present specimen was distinclty different from that of the next f. *curvata*, which has the dendriform sieve membrane. The cover membrane of the loculus, with a round cover pore, about 0.7-1 μ in diameter.

Habitat: Fresh water, planktonic.

Occurrence: In diatomite. (Specimen, no. 1251) Yamautsuri-mura, Shimogegun, Ôita Prefecture. Middle Pleistocene.

f. *curvata* GRUNOW

Pl. 17, Figs. 2a, b.

Melosira granulata f. *curvata* GRUNOW, HUSTEDT, 1930, Kieselalg., Teil. 1, p. 250, fig. 106, b.-MILLS, 1934, Index, p. 930.-CLEVE-EULER, 1951, Diat. Schweden u. Finnland, p. 25.-OKUNO, 1952, At. Foss. Diat., pl. 5, figs. 2, 3.

* 1) Read Oct. 10, 1953; received Oct. 14, 1953.

2) This research was aided by a Grant in Aid for Scientific Research from the Ministry of Education.

Differs from *Mel. granulata* var. *granulata* by the curvate frustules and chains. Loculi about 6–8 in 10 μ. In the present specimens, the sieve membranes of the loculi were dendriform, consisted of the robust bases and anastomosing branches. In many frustules, the sieve membranes were broken or lost. The sieve membrane somewhat resembles in its dendriform and netveined structure to those of *Arachnoidiscus ornatus* (OKUNO, 1949, *Bot. Mag. Tokyo, vol. 62*, p. 97, pl. 3, fig. 3), *Cocconeis scutellum* (upper valve) (OKUNO, 1950, l. c., *vol. 63*, p. 101, pl. 3, figs. 6′, 6″), and *Didymosphenia geminata* var. *curvata* (Pl. 17, figs. 5a–d). According to my researches, sieve membranes of a species and its varieties or forms, were usually of the same structure, and such a dimorphism of the sieve membrane found in the previous species and the present form is rather exceptional.

Habitat: Fresh water, planktonic.

Occurrence: In diatomite. (Specimen, no. 1141) Kampo, Keishô-Hokudô, Korea. Neogene.

Achnanthes lanceolata (BRÉBISSON) GRUNOW f. *ventricosa* HUSTEDT

Pl. 17, figs. 3a, b.

Achnanthes lanceolata (BRÉBISSON) GRUNOW f. *ventricosa* HUSTEDT, Kieselalg., Teil. 2, p. 409, fig. 863 e, f.–OKUNO, 1947, *Kagaku (Science), Tokyo, vol. 17*, p. 310, figs. 4, 5; 1952, At. Foss. Diat., pl. 19, fig. 2.

Valves lanceolate, rounded or somewhat rostrated at the ends, slightly dilated bilaterally in the middle. About 17–31 (8–40) μ long, about 6.5–8.5 (4–10) μ broad. Frustule pores transversely elongated, probably locular as in *Pinnularia*. Loculi about 13–15 (13–17) in 10μ. In the fossil frustules from Makkaribetsu-mura, the sieve membranes of the loculi were almost completely lost, and I could find only the dentiform remains of them at the borders of the loculi as shown in figs. 3a, b. In the loculi of the living frustules of *Achn. lanceolata*, KOLBE and I severally have found sieve membranes with round sieve pores arranged in transverse and oblique rows (KOLBE, 1943, *Ber. Dt. Bot. Ges., vol. 61*, p. 95, pl. 4, fig. 15; GRUNO, 1953, *Bot. Mag. Tokyo, vol. 66*, p. 7, pl. 2, fig. 2′). In the fossil frustule, on one side of the central area of the upper valve, I found a round thin membrane, quite penetrable to the electron beam (fig. 3b). This is the sieve membrane of the so-called 'horse-shoe shaped area', and which hitherto misunderstood light-microscopically to be the thickening of the frustule!

The present forma *ventricosa* is connected with *Achn. lanceolata* var. *lanceolata* by continued intermediate forms.

Habitat: Fresh water, littoral.

Occurrence: In diatomite. (Specimen, no. 1316) Makkaribetsu-mura, Abutagun, Hokkaido. Pleistocene?

Actinella brasiliensis GRUNOW

Pl. 17, figs. 4a, b.

Actinella brasiliensis GRUNOW, HUSTEDT, 1913, in A. SCHMIDT, At. Diat., pl. 292, figs. 10–19.—MILLS, 1933, Index, p. 76.

Valves linear, slightly arcuate, with broad, capitate apex and narrow, round basis. About 77–115 (30–140) μ long, and about 10–12 (7–12) μ broad at the apex. Frustule pores are holes, about 4 in 1 μ, arranged in transverse rows about 14–17 (12–19) in 10 μ. Holes rectangular to roundish-rectangular, about 8000–16000 m μ^2. In the present

specimens, I could not find the sieve membrane in the hole.

Habitat: Fresh water, Littoral.

Occurrence: In diatomite. (Specimen, no. 357, E44) Arii-mura, Minamimuro-gun, Mie Prefecture. Holocene.

Actinocyclus ellipticus GRUNOW

Pl. 17, figs. 5a, b.

Actinocyclus ellipticus GRUNOW, HUSTEDT, 1930, Kieselalg., Teil. 1, p. 533, fig. 303.—MILLS, 1933, Index, p. 85.

Valves elliptic, about 35–48 (29–100) μ: 18–35 (18–70) μ in diameter. Marginal zone striated, striae about 16 in 10 μ. Frustule pores on the valve roundish to polygonal, probably locular, arranged in longer and shorter radiating rows, or somewhat irregularly scattered. In the present specimen, frustule pores of the submarginal zone could be observed. They are about 400–500m μ in diameter. Sieve membranes of the frustule pores were completely lost.

Habitat: Marine. Pelagic?

Occurrence: In diatomite. (Specimen, no. 1346) Sawane-chô, Sado Island, Niigata Prefecture. Upper Miocene, Nakayamatôge Formation.

According to HUSTEDT, the living forms were reported by PERAGALLO from Banylus and Villefranche!

Auliscus pruinosus BAILEY

Pl. 17, figs. 6a–c.

Auliscus pruinosus BAILEY, HUSTEDT, 1930, Kieselalg., Teil. 1, p. 511, fig. 286.—MILLS, 1933, Index, p. 251.—OKUNO, 1951, *Geol. Sci. Kyoto, no. 6*, p. 61, pl. 3, figs. 1–1″.

Valves elliptic or circular, about 140 (60–140) μ in diameter. Central area orbicular, hyaline. Processes 2 (2–3), about 23μ in diameter. Frustule pores on the valve are probably holes, roundish, about 100–200m μ in diameter, about 3 in 1μ, arranged in longer and shorter, sometimes interrupted radiating rows, near the processes converging around them. Sieve membranes of the holes could not be found (fig. 6b). At the end of the process, a well preserved sieve membrane was found. The sieve membrane of the process thin, with round to roundish-polygonal sieve pores about 3.5 in 1 μ, about 60–200m μ in diameter, arranged in bundled radiating rows (fig. 6c).

Habitat: Marine. Littoral?

Occurrence: In clay. (Specimen, no. m376, and ICHIHARA-K17) The uppermost clay layer at Kôri, Neyagawa city, Kita-Kawachi-gun, Osaka Prefecture. Pleistocene, Osaka Group.

Campylodiscus Daemelianus GRUNOW

Pl. 18, figs. 1a, b.

Campylodiscus Daemelianus GRUNOW, A. SCHMIDT, 1886, At. Diat., pl. 54, figs. 1, 2.—MILLS, 1933, Index, p. 337.—OKUNO, 1951, *Geol. Sci. Kyoto, no. 6*, p. 62, pl. 3, fig. 7.

Valves suborbicular, about 120–150 μ in diameter. Marginal costae about 2 in 10 μ. Central area broad, subrectangular, scattered with round holes. Between the marginal zone and the central area, an annular hyaline zone distinct. Valves are so delicate that they are easily broken into fragments. Holes usually round to elliptic, but very variable in shapes and sizes. The membranes between the marginal costae and the sieve membranes of the holes of the central area were both completely lost leaving ragged edges. It is not obvious whether the destruction of these mem-

branes was caused by weathering or by the electron shoot in the electron microscope.

Habitat: Marine, littoral.

Occurrence: In clay. (Specimen, no. m379; Collected by M. ICHIHARA) Upper russety clay layer in Shimohozumi, Ibaragi city, Osaka Prefecture. Pleistocene, Osaka Group.

Campylodiscus echeneis EHRENBERG

Pl. 18, Figs. 2a, b.

Campylodiscus echeneis EHRENBERG, HANNA and GRANT, 1929, *Journ. Paleont. vol. 3*, p. 91, pl. 11, figs. 4, 5.—HANNA, 1933, *23-24th Ann. Rep. Florida St. Geol. Surv.*, p. 92, pl. 9, fig. 5.—MILLS, 1933, Index, p. 338.—OKUNO, 1951, *Geol. Sci. Kyoto, no. 6*, p. 623, pl. 3, fig. 6.

Valves suborbicular, about 160–200 (80–200) μ in diameter. Marginal costae indistinct. Central area narrow linear or absent. Holes round to elongated, about 1–5 μ in diameter, arranged in indistinct radiating rows. Valves very delicate and easily broken into fragments. Sieve membranes of the holes could not be found. They were probably lost.

Habitat: Marine and brackish, littoral.

Occurrence: In clay. (Specimen, no. m382, ICHIHARA–525) Shimohozumi, Ibaragi city, Osaka Prefecture. Pleistocene, Osaka Group.

Cymbella Ehrenbergii KÜTZING

Pl. 18, Figs. 3a, b.

Cymbella Ehrenbergii KÜTZING, 1844. Bacill., p. 79, pl. 6, fig. 11.—MILLS, 1933 Index, p. 551.—SKVORTZOV, 1937, *Mem. Sci. Kyoto Imp. Univ. Ser. B, vol. 12*, p. 149, pl. 6, figs. 5–7, pl. 8, fig. 6.

Valves cymbiform, slightly asymmetrical, with subrostrate ends. About 90–150 (89–153) μ long, and about 30–40 (28–40) μ broad. Rows of the frustule pores slightly radiate, about 6–9 in 10 μ in the middle and increase to 10 at the ends. Frustule pores may be locular; round to subrectangular, about 150–250mμ in diameter, about 15–18 in 10 μ. In the present specimens, sieve membranes of the frustule pores could not be found. In the fustule pores of the living form of *Cymbella australica*, I have found porous sieve membranes (OKUNO, 1953, *Bot. Mag. Tokyo, vol. 66*, p. 8, pl. 2, fig. 3′′′). According to my experiment, the sieve membranes of *Cymbella* are so delicate that they are easily broken off in the course of preparation.

Habitat: Fresh water, littoral.

Occurrence: In diatomite. (Specimen, no. 1538, E50, E52) Himekozawa in Nezumura, Chiisagata-gun, Nagano Prefecture. Neogene.

Opephora Martyi HÉRIBAUD

Pl. 18, Fig. 4.

Opephora Martyi HÉRIBAUD, HUSTEDT, 1930, Bacill., p. 132, fig. 120.—MILLS, 1934, Index, p. 1256.

Valves ovate, about 4 (4–60) μ long, about 3 (3–8) μ broad. Loculi transverse, about 10 in 10 μ. In the present specimen, reticulate sieve membranes of the loculi are well preserved. Sieve pores subrectangular, about 7 in 1 μ, about 70–140m μ long and about 70m μ broad, arranged in radiating and arcuate-longitudinal rows. Surface of the sieve membrane with minute granular dots. The specimen was photoed after shadowed by Cr-evaporation.

Habitat: Fresh water, littoral.

Occurrence: In diatomite. (Specimen,

no. 1310) Kimobetsu-mura, Abuta-gun, Hokkaido. Holocene or Pleistocene. Rusutsu Formation?

Didymosphenia geminata (LYNGBYE) M. SCHMIDT var. *curvata* SKVORTZOV et MEYER

Pl. 18, Figs. 5a–d.

Didymosphenia geminata (LYNGBYE) M. SCHMIDT var. *curvata* SKVORTZOV et MEYER, SKVORTZOV, 1937, *Mem. Sci. Kyoto Imp. Univ. Ser. B, vol. 12*, p. 169, pl. 9, figs. 5, 9, 10.

Valves arcuate-clavate, with subrostrate apex and somewhat narrow basis, about 100–127 μ long, about 30–35 μ broad. Frustule pores arranged in radiating rows, about 7 in 10 μ. Frustule pores rectangular to roundish-rectangular, probably locular, in Tawarasaka specimens about 600–1500m μ long and 600–650m μ broad (figs. 5a–c). In Yatsuka specimens about 400–600m μ long and about 300–500m μ broad (fig. 5d). Frustule pores are probably closed with thin sieve membranes supported by 2–8 dendriform thickenings. Such sieve membranes with dendriform thickenings were found by me also in *Arachnoidiscus ornatus* (OKUNO, 1949, *Bot. Mag. Tokyo, vol. 62*, p. 97, pl. 3, fig. 3; 1953, 1. c., *vol. 66*, pp. 123–124, pl. 1, fig. 11) and in the upper valve of *Cocconeis scutellum* (OKUNO, 1950, 1. c., *vol. 63*, p. 101, pl. 3, figs. 6–6″).

Habitat: Fresh water, littoral.

Occurrence: In diatomite. Figs. 5a–c. Tawarasaka, Ureshino-chô, Fujitsu-gun, Saga Prefecture. (Specimen, no. 1643, E222) Neogene. Fig. 5d. Yatsuka-mura, Maniwa-gun, Okayama Prefecture. (Specimen, no. 1107) Pleistocene.

Navicula americana EHRENBERG

Pl. 18, Figs. 6a–c.

Navicula americana EHRENBERG, HUSTEDT, 1930, Bacill., p. 280, fig. 464.—MILLS, 1934, Index, p. 975.

Valves linear, with rounded ends, about 65 (30–154) μ long, about 15 (10–30) μ broad. Axial area broad, about half the width of the valve, dilated orbicularly in the middle. Frustule pores are holes, arranged in slightly radiating rows, about 15–18 in 10 μ. Holes roundish to subrectangular, about 30 in 10 μ, about 130–140m μ in diameter. Sieve membranes of the holes could not be found.

Habitat: Fresh water, littoral.

Occurrence: In diatomite. (Specimen, no. 1543, E157) Nishise-mura, near Hitoyoshi-chô, Kuma-gun, Kumamoto Prefecture. Pleistocene.

Explanation of Plate 17

L.M.: Light Micrograph. E.M.: Electron Micrograph.
Electron micrographs without special remarks were all obtained from the direct preparations.

Figs. 1a, b. *Melosira granulata* (EHRENBERG) RALFS. Yamautsuri-mura, Oita Pref. 1a (L.M. ×1000). 1b (E.M. Collodion. ×8300).

Figs. 2a, b. f. *curvata* GRUNOW. Kampo, Korea. 2a (L.M. ×1000). 2b (E.M. Collodion. ×21000).

Figs. 3a, b. *Achnanthes lanceolata* (BRÉBISSON) GRUNOW f. *ventricosa* HUSTEDT. Makkaribetsu-mura, Hokkaido. 3a, End of the valve 3b, Middle of the upper valve, showing the well preserved sieve membrane of the 'horse-shoe shaped area' (left side in the figure). 3a, b (E.M. Collodion. ×14000).

Figs. 4a, b. *Actinella brasiliensis* GRUNOW. Arii-mura, Mie Pref. 4a (L.M. ×1000). 4b (E.M. ×11000). 4a, b, Obtained from the same valve.

Figs. 5a, b. *Actinocyclus ellipticus* GRUNOW. Sawane-chô, Sado Island, Niigata Pref. 5a (L.M. ×300). 5b (E.M. ×9000).

Figs. 6a-c. *Auliscus pruinosus* BAILEY. Kôri, Neyagawa city, Osaka Pref. 6a (L.M. ×300). 6b, A portion of the valve. (E.M. ×6000). 6c, Central portion of the sieve membrane of the process. (E.M. ×7200).

Explanation of Plate 18

Figs. 1a, b. *Campylodiscus Daemelianus* GRUNOW. Ibaragi city, Osaka Pref. 1a (L.M. ×300). 1b, Showing the marginal zone (left side in the figure) and the central area (right side in the figure). (E.M. ×2000).

Figs. 2a, b. *Camp. echeneis* EHRENBERG. Ibaragi city, Osaka Pref. 2a (L.M. ×200). 2b (E.M. ×2000).

Figs. 3a, b. *Cymbella Ehrenbergii* KÜTZING. Nezu-mura, Nagano Pref. 3a (L.M. ×400). 3b (E.M. ×9000).

Fig. 4. *Opephora Martyi* HÉRIBAUD. Kimobetsu-mura, Hokkaido. (E.M. Collodion substrate. Chromium shadowing. ×13000).

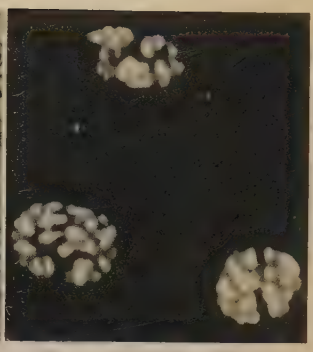
Figs. 5a-d. *Didymosphenita geminata* (LYNGBYE) M. SCHMIDT var. *curvata* SKVOROTZOV et MEYER 5a-c, Ureshino-chô, Saga Pref. 5a (L.M. ×500). 5b (E.M. ×6000). 5c (E.M. (×15000). 5d, Yatsuka-mura, Okayama Pref. (E.M. ×10000).

Figs. 6a-c. *Navicula americana* EHRENBERG. Nishise-mura, Kumamoto Pref. 6a (L.M. ×600). 6b, Middle of the valve (E.M. ×3000). 6c, End of the valve (E.M. ×3000).

1a

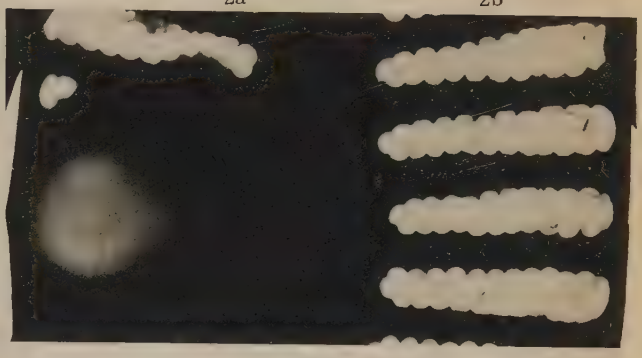
1b

2a



2b

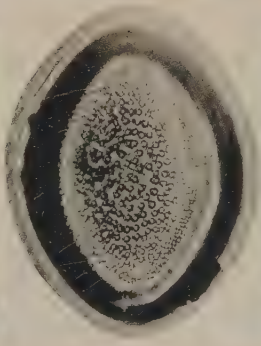
3a



3b

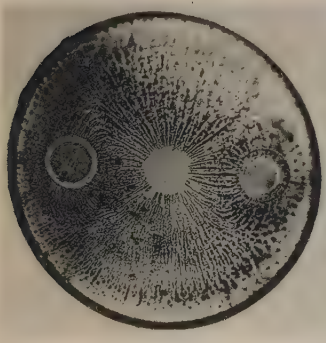
4a

4b



5a

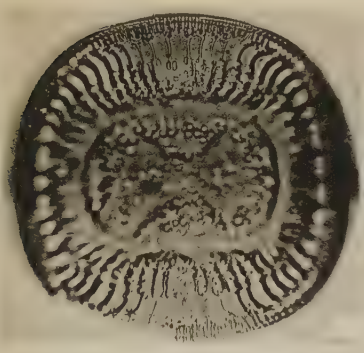
5b



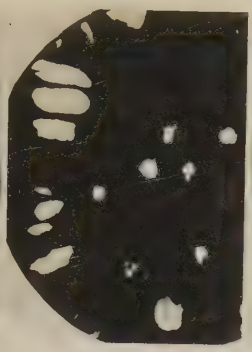
6a

6b

6c



1a

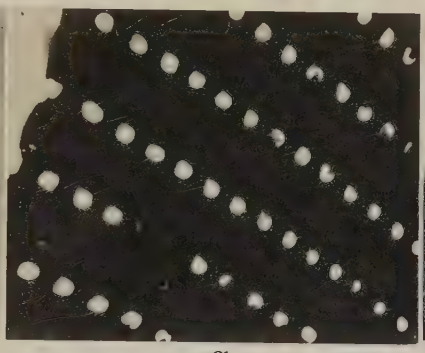


1b

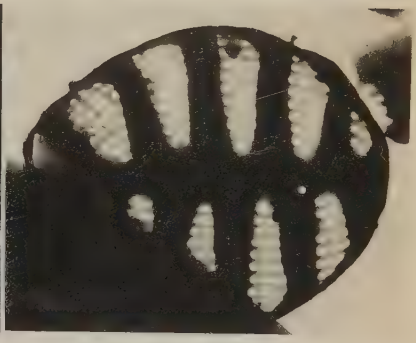
2a

2b

3a

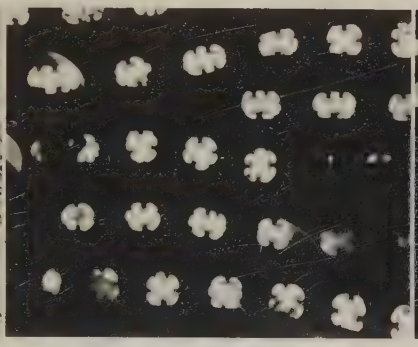


3b

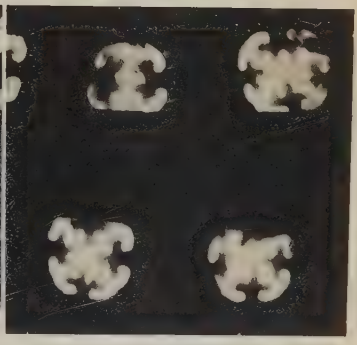


4

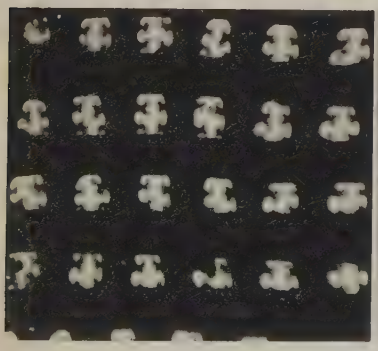
5a



5b



5c



5d

6a

6b

6c

Trans. Proc. Palaeont. Soc. Japan, N. S., No. 14, pp. 149—153, Pl. 19, Aug. 15, 1954

248. ON THE MIOCENE PECTINIDAE FROM THE ENVIRONS OF SENDAI. PART 5; ON "*PECTEN*" *ARAKAWAI* NOMURA*

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仙台附近中新統産 Pectinidae, その 5, (*Pecten arakawai* NOMURA について):
野村七平は 1935 年に青森県西津軽郡大戸瀬村田野沢から *Pecten arakawai* を記載し, その後 1940 年に仙台附近の茂庭層からこれを報告したが, 標本は何れも不完全であつた。筆者は野村が報告したと同じ場所の茂庭層から *Pecten arakamai* に同定される完全な標本を採集したので, その特徴を記載しその地質学的意義に触れた。
増田孝一郎

Pecten arakawai was first described by S. NOMURA in 1935 from the Miocene Tanosawa formation at Tanosawa, Odose-mura, Nishi-Tsugaru-gun, Aomori Prefecture, and subsequently it was reported from the Miocene Moniwa formation at Kita-Akaishi, Oide-mura, Natori-gun, Miyagi Prefecture. Unfortunately, NOMURA's holotype consisted of an unfavorably preserved specimen and his paratypes were also incomplete and the hypotype reported by him subsequently from the southern border of Sendai was also imperfect. Thus, subsequent workers have been confused in interpreting the species.

Lately the writer together with some students of the College of Education of the Tohoku University, collected beautiful specimens which are referable to *Pecten arakawai*. Taking this opportunity, the writer wishes to describe the characters of *arakawai* and to make clear its relationship with other known species by a comparative study. The collections preserved in the Institute of Geology and Paleontology, Tohoku University, the Saito Ho-on Kai Museum, and in the Department of Geology, College of Education, Tohoku University, all in Sendai City, were studied in connection with this problem.

Arakawai is now known to occur in the Tanosawa formation in Aomori Prefecture, the Ôtsutsumi, Moniwa and Oido formations in Miyagi Prefecture, and its occurrence is expected from formations of similar geological age. The geological age of the formations which have yielded this species may all be referred to early Miocene.

Acknowledgements are due to Dr. Kotora HATAI of the Department of Geology, College of Education, Tohoku University, for supervising the present work, and also to the students of the same institution for their assistance in the field.

* Read Oct. 10, 1953; received Oct. 14, 1953.

Family Pectinidae

Subfamily Pectininae

Genus *Chlamys* (BOLTEN) RÖDING, 1798

Chlamys arakawai (NOMURA), 1935

Plate 19, figures 1a-b, 2a-b, 3a-b, 4, 5, 6.

1935. *Pecten (Pecten) arakawai* NOMURA, *Saito Ho-on Kai Mus., Res. Bull., no. 6*, pp. 41-42, pl. 4, figs. 1, 2.

1940. *Pecten (Chlamys) arakawai* NOMURA, *Sci. Rep., Tohoku Univ., Ser. 2, vol. 21, no. 1*, p. 17, pl. 2, figs. 1, 2, 3.

The original description of this species is as follows:—

"Shell very large, attaining about 110 mm. in height, subcircular in outline, slightly higher than long, moderately convex, subequivalve, almost equilateral except for ears; radiately ribbed closely; test medium in thickness; sides of disc slightly concave in the middle and embracing an angle of about 90° at beak; basal margin evenly rounded. Right valve with numerous more or less squarish, imbricated ribs, usually split into two by division, and rarely associated with an intercalarly (or two?) between the ribs on the lower part of the disc-surface; interspaces nearly equal to the ribs themselves in breadth, except both sides where they are wider; whole surface marked by fine, distinct, concentric lines. Hinge-line almost half the length of the disc; anterior ear much produced with a large, deep, triangular notch below; posterior ear considerably shorter than the anterior, and obliquely truncated. Interior smooth except for the marginal portion where it is crenulate in harmony with the outer sculpture. Left valve apparently similar to the right in all respects, but the ribs are narrower, and the interspaces are proportionally wider".

The specimens collected by the writer with the assistance of some students of the College of Education, Tohoku University, take the following description.

Shell large and thick, higher than long, the right valve being less convex than the left, and both valves radiately ribbed. Right valve with 27–35 distinct, more or less squarish, somewhat rounded, bifurcating, imbricated radial ribs, sometimes with very faint intercalary threads between the radials; radial ribs nearly equal to their interspaces in breadth, and usually bifurcate (or rarely trifurcate), and sometimes single; anterior auricle much larger and longer than the posterior, and sculptured with imbricated radial threads and concentric growth lines, byssal notch distinct and byssal area wide; posterior auricle similar to the anterior in sculpture, though the radial threads of the posterior are a little more distinct than those of the anterior; hinge with conspicuous cardinal crura, ctenolium, and deep resilial pit. Left valve with imbricated, radial ribs, intercalary threads and concentric growth lines; radials 27–35 in number, distinct, squarish and not bifurcating, nearly equal to interspaces in breadth on upper half of disc but narrower on the lower half; auricles with imbricated radial threads and concentric lines, the anterior larger than the posterior; hinge with deep resilial pit and distinct cardinal crura corresponding to that of right valve. Interior surface smooth except for marginal serration.

Dimensions (in mm.):—

Valve	Right	Right	Right	Left	Left	Left
Height	128	120	106	116	115	65
Length	115	110	90	100	100	55
Hinge-length	63	60	—	53	53	35
Depth	18	14	17	23	23	11
Apical-angle	90°	90°	90°	90°	90°	90°

Remarks:—This species is characterized by the right valve having a thick shell provided with 27 to 35, more or less squarish, bifurcating, imbricated radial ribs, and by the anterior auricle being larger than the posterior and provided with a deep byssal notch and also by the characteristic hinge-area. The left valve is characterized by having squarish, non-bifurcating radial ribs with intercalary threads between them. The shape of the shell is also noteworthy, in anterior-posterior view the shell convexity is asymmetrical, the maximum depth being situated posteriorly in the right valve, and anteriorly in the left. The hinge of the right valve is variable in form, being when very thick, provided with a deep resilial pit which is large and long, extending, obliquely posteriorly, and the hinge plate is wide, flat, and sculptured with fine striae parallel to the hinge. However, when the hinge is thin, the cardinal crura is conspicuous, the resilial pit small and short, and there is no flat hinge-plate. The hinge of the left valve is smaller than that of the right, and the resilial pit extends obliquely postero-ventrally. The intercalary threads on both right and left valves appear on the lower half of the disc, but do not become strong in the right and remain faint, while in the left, they become stronger towards the ventral margin.

In general features, the above described species resembles *Chlamys ingeniosa* (YOKOYAMA), a species which was first described by M. YOKOYAMA upon a single right valve from the Miocene Nanao formation near Nanao City in Ishikawa Prefecture. However, YOKOYAMA's species can be distinguished from the present one by having a fewer number of radial ribs (about 20), which bifurcate near the beak and by the interspaces between the radials being narrower.

Chlamys meisensis (MAKIYAMA), first described by J. MAKIYAMA from the Miocene Mankôdô formation in North Korea, can be distinguished from the present one by having a less number (23–27) of flat-topped, roundly-edged radial ribs, by the more stronger intercalary threads which appear near the beak.

Chlamys arakawai (NOMURA) is also related to *Chlamys halimensis* (MAKIYAMA), *Ch. shirahamensis* (NOMURA and NIINO) and *Ch. miurensis* (YOKOYAMA), but can be distinguished from the mentioned species by the number and characteristics of the radial ribs and intercalary threads, and also by the convexity of the valves.

The paleoecological conditions of *Chlamys arakawai* (NOMURA) can be inferred only from the rocks from which it was collected and from the data available from its associated fossils. The known occurrences and nature of the embedding rocks are outlined in the following lines as a means for deciphering the past conditions under which the species lived.

At the type locality, which is the Tanosawa formation exposed at Tanosawa, Odose-mura, Nishi-Tsugaru-gun, Aomori Prefecture, this species was collected from an impure limestone or coquina and also from a conglomerate bed. Among the fossils found in association, the genera *Clinocardium*, *Saxidomus*, *Dosinia*, *Solen* and *Panope* are generally found in the Recent Seas in very shallow water, burrowing into silt, or mud, while the associated pectinid fossils take to cleaner water. Since it seems that the fauna represents a thanatocoenose rather than a biocoenose, the presence of such mentioned genera

in impure limestone may suggest that they were brought to their place of burrial after death. *Arakawai* also occurs in the Moniwa formation at Moniwa, Oidemura, Natori-gun, Miyagi Prefecture in association with other bivalves and gastropods, balanids, bryozoans, brachiopods, simple corals and less commonly also with shark's-teeth and echinoid tests. The entombing rocks of the fossils mentioned is a granule conglomerate. In the northwestern part of Sendai, this species occurs in the Ôtsutsumi formation at Ôtsutsumi, Miyatoko-mura, Kurokawa-gun, Miyagi Prefecture, in association with pectinid and brachiopod remains. The rocks embedding the fossils consists of tuffaceous, very coarse sandstone or conglomeratic sandstone. In the Oido formation at Wakuya-machi, Tôda-gun, Miyagi Prefecture, *Chlamys arakawai* occurs in a conglomeratic tuffaceous sandstone near the basal part of the formation which comprises tuff, tuffaceous sandstone, conglomeratic tuff, and an alternation of tuffaceous sandstone and sandstone. The fossils other than the one in question comprises pectinids, some bivalves, very few gastropods and several brachiopods, while *arakawai* is rather rare.

Thus from the foregoing, it may be noticed that, in general, *Chlamys arakawai* occurs from coarse grained sediments more commonly than from fine grained ones, and it is also worthy of mention that it does not take to a region in which muddy sediments prevail. The associated fauna of *arakawai* in the regions above mentioned, all point to warm thermal conditions. Therefore, it is inferred that *Chlamys arakawai* inhabited a clean sea bottom influenced by warm thermal conditions and that the depth range of the species may have been in the eulittoral zone.

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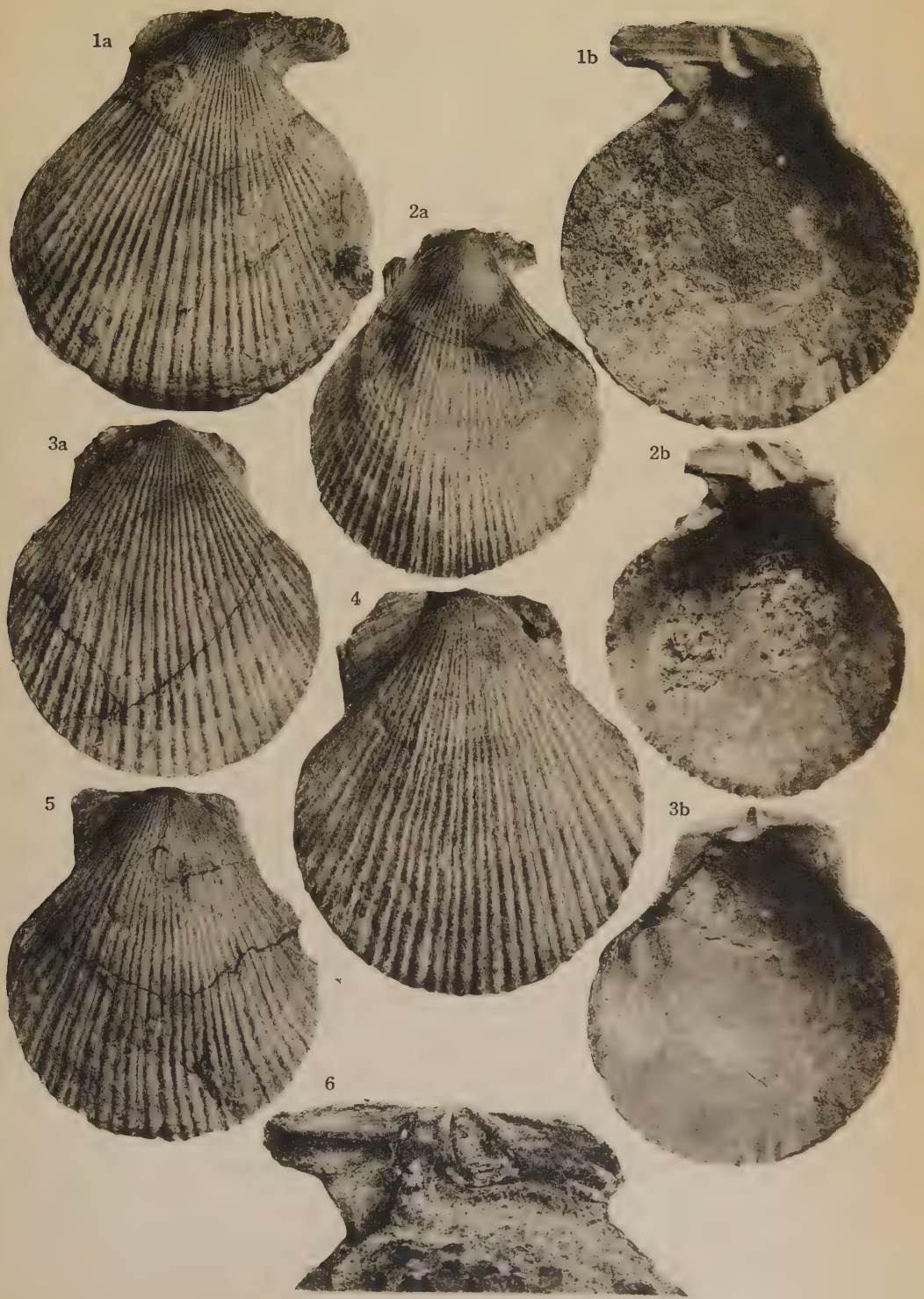

K. KUMAGAI Photo.

Explanation of Plate 19

Figs. 1a–b, *Chlamys arakawai* (NOMURA), a. Right valve, ×1/2, b. Internal view of 1a, ×1/2. Loc. River cliff of Natori-gawa near the Akiu Car-line Station at Kita-Akaishi, Oide-mura, Natori-gun, Miyagi Prefecture.

Figs. 2a–b, *Chlamys arakawai* (NOMURA), a. Right valve, ×1/2, b. Internal view of 2a, ×1/2. Loc. Same as above.

Figs. 3a–b, *Chlamys arakawai* (NOMURA), a. Left valve, ×1/2, b. Internal view of 3a, ×1/2. Loc. Same as above.

Fig. 4, *Chlamys arakawai* (NOMURA), Left valve, ×1. Loc. Same as above.

Fig. 5, *Chlamys arakawai* (NOMURA), Left valve, ×1/2. Loc. Same as above.

Fig. 6, Hinge area of *Chlamys arakawai* (NOMURA), Right valve, ×1. Loc. Same as above.

PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

「日本古生物学会第58回例会」昭和29年6月26日東北大学理学部地質·古生物学教室に於て開催す（参会者29名）。講演者並に講演題目次の如し。

長門三疊系産 *Hepaticites Oishii*, sp. nov. と *Taeniopteris yamanoiensis*, sp. nov.（代読）..... 高橋英太郎・藤岡一男

Dictyophyllum japonicum YOKOYAMA の形態について（代読).....高橋英太郎・藤岡一男

朝鮮第三紀植物化石 IV 及び V（代読）..... ..... 藤岡一男

Spirostigmoilinella, new foraminiferal genus from the Miocene of Japan（代読)..... ..... MATSUNAGA, Takashi

Triloculinoides asanoi, n. gen., n. sp., from the Japan Sea off the Coast of Kashiwazaki-shi, Niigata, Japan.（代読)..... ..... OINOMIKADO, Tsuneteru and MATSUNAGA, Takashi

秋田県須郷田層の有孔虫化石について..... ..... 岩佐三郎・菊池良樹

唐津炭田杵島層の有孔虫化石について ...浅野 清

新潟県青海石灰岩，特に黒姫山を中心とせる地域の層位学古生物学的研究（代読).....河田茂磨

仙台附近の中新世 Pectinidae 第七報...増田孝一郎

On Some Species of Fossil Mytilidae from the Tertiary Formations in the Ninohe District, Iwate Prefecture, Japan. .... AOKI, Shigeru

Remarks on Certain Genera and Some Species of Lucinids from Japan.（Notes on Japanese Lucinid Mollusca-Part 2）（代読） ..... HIRAYAMA, Katsumi

Faunal Analysis of Fossil Molluscs from the Raised Beach Deposits of Kamakura, Kanagawa Prefecture .....KANNO, Saburo

Trigonia japonica 及びそれと近縁な三角貝類について（代読).....小林貞一・天野昌久

Izumonauta, a new genus of the Argonautinae with a Note on their rare but gregarious fossil Occurrence（代読)...KOBAYASHI, Teiichi

A Contribution toward Palaeo-Flumenology, Science of the Oceanic Current in the Past, with a Description of a New Miocene *Aturia* from Central Japan（代読） .... KOBAYASHI, Teiichi

Macrophthalmus Yagii, n. sp. from Yobake, Chichibu..... IMAIZUMI, Rikizo

ERRATA

ERRATA to Article 238, N.S., pp. 83-88 (MASUDA)

p. 83, right column, line 7: add "7"

p. 85, left column, line 7 from below: erase "8a-b"

ERRATA to Article 239, N.S., pp. 89-95 (HAYASAKA)

p. 91, left column, line 3: leave out "are described"

p. 93, right column, line 21: read "accordingly" for "notwithstanding"

p. 94, right column, line 11: read "septum" for "Septum"

p. 95, right column, lines 11-12 from below: read "stress is not laid on..." for "it is not laid stress on..."

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 14, pp. 155-158, Pl. 20, Aug. 15, 1954

249. DISCOVERY OF *NELUMBO* FROM THE ASUWA FLORA (UPPER CRETACEOUS) IN FUKUI PREFECTURE IN THE INNER SIDE OF CENTRAL JAPAN*

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足羽植物群でのハスの発見： 足羽植物群（上部白堊系）からハスの葉片 *Nelumbo orientalis*（新種）を発見し，記載を試みた。産出地は福井県今立郡上池田村皿尾。この新種は東亜最古の記載種であると思はれると同時に，足羽植物群を新羅統上部，アラスカの上部白堊系植物群と対比するのに重要な役割を演じている。 松尾秀邦

Introductory

Lotus-leaves have not hitherto been discovered in the Cretaceous Flora of Japan, although they have been known from the Palaeogene formations of some coal-mines in Kyusyu, Hokkaido and Saghalien (the basal part of Neogene). These have been described by Prof. S. ENDO (1934) by the name of *Nelumbo nipponica*.[1] And this species has been reported by Dr. H. YABE (1944) from the Ube coal-field, Yamaguchi Prefecture.[2] Meanwhile, the occurrence of *Nelumbo* sp. has been reported by Prof. I. TATEIWA (1934) from Korea.[3] The material was collected by S. SHIMAMURA from the uppermost part of the Shiragi Series (Upper Cretaceous deposits) at the Chinan district, North-Zenra-Do, southern Korea. However its paleontological description has not been published until now. Therefore, this new species of Asuwa Flora is the oldest remains of the lotus-leaf in eastern Asia, as far as is known to the writer. Outside eastern Asia, however, lotus-leaves are known to occur in the upper Cretaceous floras of Alaska Peninsula, North America and southern France.[4] According to ENDO's paper,[5] HEER once thought that the genus *Nelumbo* originated somewhere in the Arctic region during the upper Cretaceous time.

Then, the occurrences of fossil species of *Nelumbo* may prove to be useful for the correlation of the upper Cretaceous formations at least in the Arctic Region.

It is generally considered in Japan that the recent lotus (*Nelumbo nucifera* GAERTIN) of our country was imported from China in an ancient time, while Dr. T. MAKINO maintains that it is monogenetic, its place of origin having been in India. However, Dr. I. OGA is sceptic of MAKINO's monogenetic theory, on the basis of his researches on the ancient lotus seeds from Pu-lan-tien (普蘭店) in South Manchuria, and from Kimikawa (検見川), Chiba Prefecture,

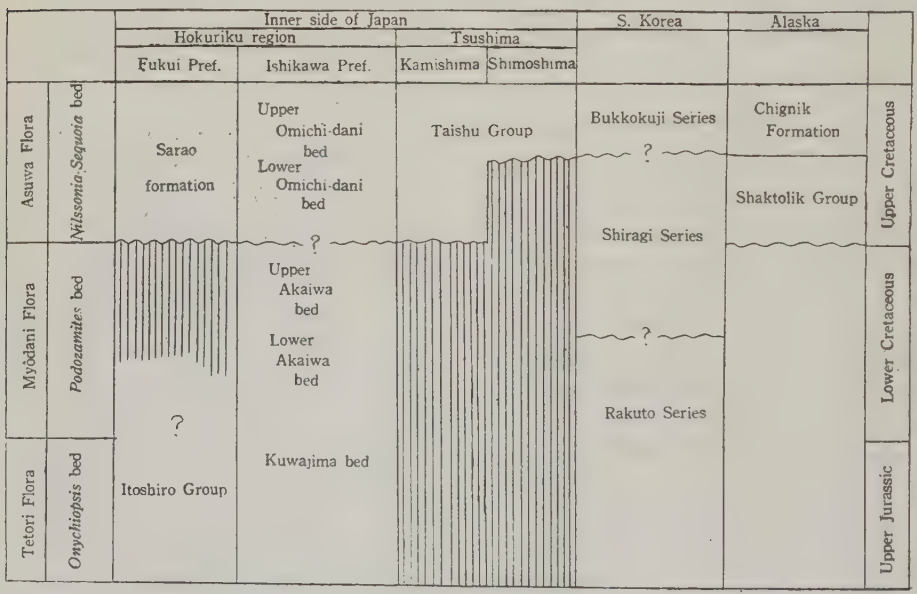
* Read Oct. 10, 1953; received Dec. 21, 1953.

in the vicinity of Tokyo, which are believed to be ca. 2,000 years old. According to his opinion the ancient lotus and the recent *Nelumbo* are synonymous: taking the occurrences of lotus in the Japanese Islands and Manchuria where ancient forms are known origin, instead of the monogenetic in India.

The oldest lotus of the Far East is a new species for which the writer proposed the name *Nelumbo orientalis* and will be described below.

Geological Notes

The fossil leaves dealt with in this note were discovered in the abandoned debris of a closed mine (activity in 1943–46), near the village of Sarao, Kami-ikeda-Mura, Imadate-Gun, Fukui Prefecture.* These debris were derived without doubt from a formation of alternating beds with fine tuffaceous sandstone and some dark coloured calcareous shale. The rock specimen containing three leaves of *Nelumbo orientalis* nov. sp.



The writer is of opinion that the Tetori Flora should be limited within the Itoshiro Group,[7] because this group is a deposit of a land facies, and its basal part contains boulders of rocks of the lower horizon of the Kuzuryu Group which is of the marine facies.

The correlation of the bed with the Asuwa Flora with the Taishu Group of Is. Tsushima is based on the fact that the rock characters of the Sarao formation resembles those of this group, containing a tuffite-like rock and a tuffaceous coarse sandstone (this sandstone seems to coincide with TATEIWA's "Bed intercalated by quartz-porphyry").

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together with Sequoian twigs is a compact tuffaceous shale, which belonging to the Sarao formation** of the upper Cretaceous deposits of Hokuriku region, on the Japan Sea side of Central Japan.

These upper Cretaceous deposits contain abundant plant fossils, as the writer in cooperation with S. KIDA, reported to the Geological Society of Japan on the occasion of its 60th Anniversary,[6] its flora having been referred to consist, beside the new *Nelumbo*, of *Cladophlebis*, *Sagenopteris*, *Osmunda*, *Tumion* (*Metasequoia* like twig), *Sequoia*, *Nilssonia*, *Ginkgoites*, *Populus*, *Phyllites*, etc.

On that occasion we introduced the name of the Asuwa Flora for denoting the occurrence of the plant fossil bed. This flora is distinguished from the Tetori Flora, and corresponds to the upper Cretaceous Flora of Alaska. Concerning the Asuwa Flora, the writer wishes to report in another occasion.

Stratigraphical relations of the upper Cretaceous of the Inner side of Japan, South Korea and Alaska Peninsula are suggested to be as followed.

Description of Species

Family Nymphaceae

Nelumbo orientalis, nov. sp.

cfr. *Nelumbo Kempii* (HOLLICK) HOLLICK (1906); *U.S. Geol. Survey Monograph L*, p. 61, Pls. XIII–XVI.

cfr. *N. nipponica* ENDO (1934); *Japan. Jour. Geol. & Geogr. Vol. XI*, p. 255–258, Pl. XXXVI–XXXVIII.

cfr. *N. dowsoni* HOLLICK, BROWN (1936); *U.S. Geol. Survey Prof. Paper 189-I*, p. 250, Pl. 48, fig. 11.

cfr. *N. nipponica* ENDO, YABE (1944); *Proc. Imp. Acad. Tokyo, Vol. XX*, p. 725–731, fig. 3.

Two leaves on a slab of shale, leaves suborbicular, 12 cm in diameter, margin slightly undulate. Petiole stout suggesting to be 0.4–0.5 cm wide in compressed state. Primary ribs assumed to be 22 and 26, respectively, in number, radiating from center of leaf, and forking uniformly and dichotomously two or three times with angles of 30 to 50 degrees; first fork usually at about a half of the length. Areolation fine but distinctly impressed, commonly forming numerous regular hexagonal and pentagonal meshes and rarely rhombic forms.

Fossil species of *Nelumbo* is characterized chiefly on the basis of differences in the number of radial veins. But in recent species can not be distinguished from one another by the following reason; according to BROWN's discussion on the two recent species of *Nelumbo*, the number of veins in the American lotus (*Nelumbo lutea*) varies from 18 to 25, with 22 as an average; while in the East Indian species (*N. nucifera*) the average is 20. Then, Dr. I. ÔGA shows that the vein number of *N. nucifera* of Japan varies from 19 to 25, 21 being the dominant number, followed by those with 22. Thus he is inclined to disregard the number of radial veins as well as the diameter and the form of leaves, as specific characteristics.

The writer, however, agrees to BROWN's opinion that, as fossils are formed and found by chance, and the material is scanty, the difference in the number of veinlets would be useful for specific characterization of fossils.

This new species has a somewhat more numerous radial ribs than the other fossil species, because *Nelumbo nipponica* is assumed to have 21, *N. dowsoni* has 18, and the other American fossil species is assumed to have 11 to 18 veins. Then *N. nipponica* is closely

** 皿尾累層

related to the recent species *N. nucifera*, and it appears to be rather closely related to the American lotus. This is an interesting fact that American lotus is more closely related to the Far Eastern fossil species than to the American fossil species.

Moreover, the size of leaves looks to be smaller than the other species, as *N. nipponica* measures the maximum diameter of 60 cm, *N. Kempii* is a larger type, but *N. dowsoni* assumes the *Brasenia* size. However, BROWN considers that these small leaves are of a single upper Cretaceous species, having the maximum diameter of 4.4 cm. The indetermined south Korean species was recorded to be of a small size.

Locality: 600 m west from the village of Sarao, Kami-ikeda-Mura, Imadate-Gun, Fukui Prefecture.
Lat. 35°51′40″N. Long. 136°21′29″E
Geological horizon: Sarao formation, Asuwa Flora (upper Cretaceous).
Collector: H. MATSUO, July 12, 1953.
Depository: Geological Institute of Kanazawa University. Reg. No. GKZ10018a (Type-specimen, under surface) and No. GKZ 10018b (upper surface).

Acknowledgments

The writer wishes to express his sincere thanks to Prof. K. OZAKI of the Geological Institute, and Prof. G. MASAMUNE of the Biological Institute, Kanazawa University, for their valuable advices and suggestions given to him in this study. To Prof. I. TATEIWA of the Tokyo University and to Dr. I. ÔGA, the President of the Lotus Research Society in Japan, the writer is indebted for knowledge on the fossil Korean lotus, and the ancient and recent lotus, respectively. To Prof. I. HAYASAKA of the Hokkaido University thanks are due to his kind criticism and reading of manuscripts.

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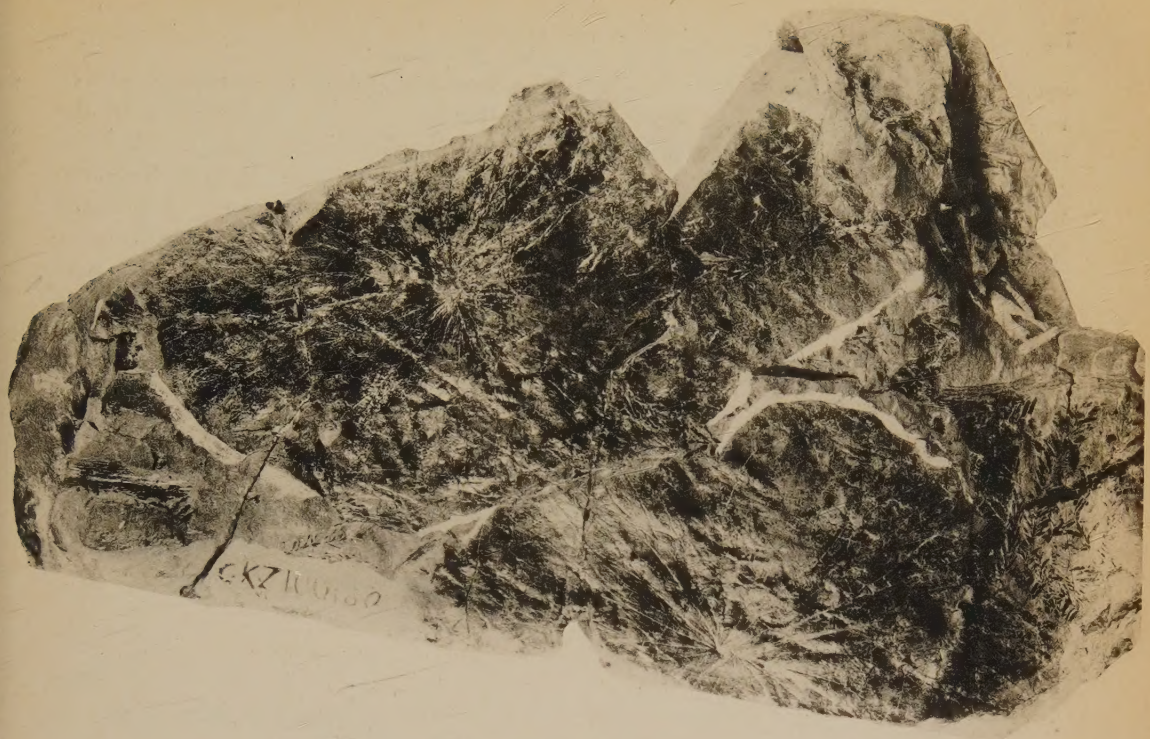
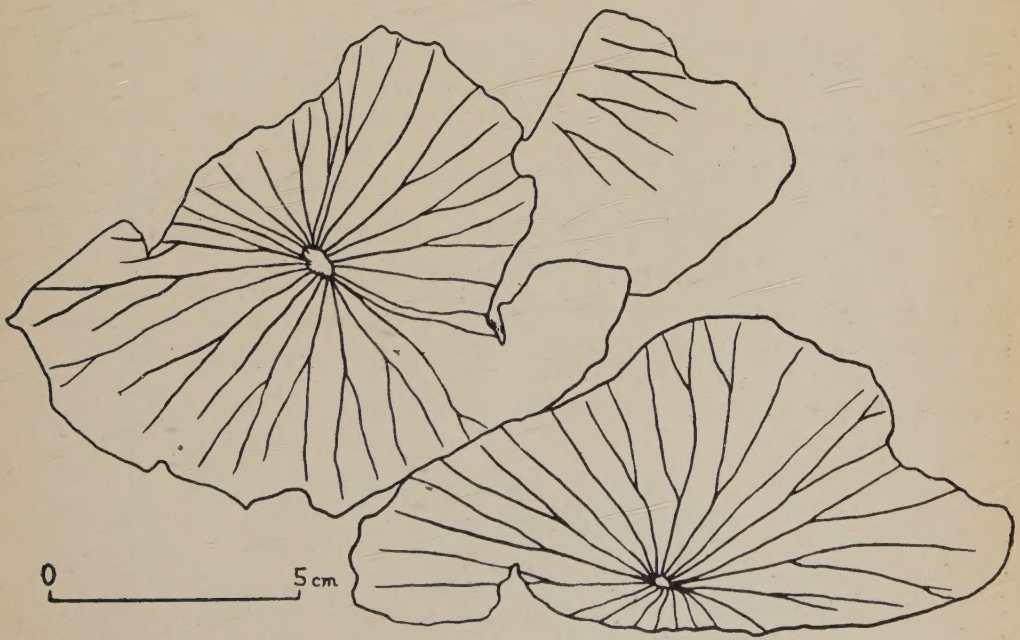
Plate 20

Nelumbo orientalis, nov. sp.

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5 cm

1954年度・例会開催予定

第59回例会	金沢	10月9日	*9月25日
年会	東京	12月下旬	*11月30日
尚年会の機に「日本第三系微化石層位学」のシンポジウムを行ふ予定 （世話人　浅野　清）			

講演御希望の方は＊に示す時日までに本会宛御申込下さい

会則変更

1954年4月30日秋田大学で開かれた日本古生物学会年会席上次の如く会則第13条が改正された。（括弧中は従来のもの）

第13条……会費は国内正会員600円（400円），外国会員3$（2$）とする。

付則

① 年2回迄の分納を認める。

② 1954年度（1月～12月）から本会則による。

1954年8月10日　印刷
1954年8月15日　發行

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Announcement

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(49 Plates and 68 Pages)

issued March 1, 1954

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Climatic Change in Japan since the Pliocene Epoch (1911).
Fossils from the Miura Peninsula and its Immediate North (1920).
Fossils from the Upper Musashino of Kazusa and Shimosa (1922).
Mollusca from the Coral-bed of Awa (1924).
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Change in By-laws

On the occasion of the Annual Meeting of the Palaeontological Society of Japan, held on April 30, 1954, it was decided upon to revise Article 13 as indicated (in italic) below.

Article 13. Rates for annual dues shall be *600* Yen (Domestic) for regular members and *3* dollars for foreign members.

Addendum

According to the By-laws of the Society, for the fiscal year of 1954 (January to December), foreign members shall receive, besides the Journal, special papers as issued (postage included).